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Enhancing Bioinformatics and Genomics Courses: Building Capacity and Skills via Lab Meeting Activities

Sub-title: Fostering culture of critical capacities to read, write, communicate and rigorously exchange on scientific information

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Abstract

Reading, writing, publishing and publicly presenting scientific works are vital for young researcher's profile building and career development. Generally traditional educational curricula do not offer training possibilities to learn and practice how to prepare, write and present scientific works. These are rather part of Lab meeting activities in research groups. The lack of such training is more critical in some developing countries as this adds to the rare opportunities to discuss and get exchanges on up to date scientific literature.

Here we relate our experience in introducing a weekly one-day Lab meeting in the framework of two three months courses on Bioinformatics and Genome Analyses we organized. The main activities developed during these Lab meetings included scientific literature follow up as well as preparing and presenting oral and written scientific reviews. These activities proved to be useful for student's self-confidence building, for enhancing their active participation during the lectures and practical sessions as well as for the positive impact on running the whole course program. Lab meeting activities incorporation significantly improved the capacity building of the participants, their analytical and critical reading of scientific literature as well as communication skills.
In this work we show how we proceeded with the different steps involved in the implementation of Lab meeting activities and recommend their regular setting up in similar courses.

Lab meetings are at the heart of scientific life as they provide exceptional environment for developing skills in team work, networking, exchange on research advances and for enhancing self-confidence and career building by offering young researchers to learn how to:
- prepare and present personal research findings;
- select and discuss challenging papers;
- develop and hone analytical skills;
- practice communication skills.

We adapted this concept by incorporating a weekly one-day Lab meeting in the organization of two three months “Bioinformatics and Genome Analyses” courses[1] we organized at the Institut Pasteur Tunis, Tunisia. The course was intended for about twenty selected young PhD students and researchers with background in Biology, Mathematics, Statistics or Computer Science. It was focused on topics related to bioinformatics, comparative genomics, metagenomics, genome variant analyses and programming in a Unix environment.

In order to foster the participants involvement in the Lab meeting activities, each participant had to prepare a synthetic review based on some selected bibliographic resources. This “bibliographic project” constituted a significant component of the course outcome and had to be formally presented at the end of the course. For that purpose, a large number of quality published papers encompassing most of the course topics, were specifically collected and passed to the participants. These documents helped the participants to follow the course program and to select adequate papers for their respective projects.

Central activities during Lab meetings included the progress in the preparation of the different projects, the follow up of recent scientific literature, critical reading of papers, reviews preparation and presentation as well as ideas sharing through discussion.

Figure 1 shows the steps we followed in the activities development. Four main operational objectives constituted the backbone of the procedure implementing these activities:

I. Training on reading scientific literature;
II. Preparation of oral presentation and synthetic reviews;
III. Proceeding and leading Lab meetings and
IV. Final review presentation and evaluation.

In the following we develop the content of these activities and introduce their implementation in the context of the course program.

I. Training on reading scientific literature

One of the main objectives of Lab meeting activities was to prompt participants to critically read scientific literature and initiate them to write reviews summarizing research papers. The three following steps describe how we proceeded.

I.1 Collect relevant bibliographic resources and "Sign in" top scientific journals

The organizers collected and passed to the participants a large number of pertinent and seminal published articles covering most topics of the course program. They are mainly relevant to: genome sequencing technologies, genome assembly, gene prediction methods, genome analyses, whole genome alignments, genome structural variants, phylogenomics, metagenomics, systems biology, synthetic biology, microbiome, giant viruses, genome resources, main genome sequencing projects and studies of specific genomes. Participants had to identify the core papers to consider for their bibliographic projects.

For the follow up of weekly published scientific literature, the participants had to "sign in" some scientific journals that traditionally publish works related to the course topics, so that to regularly receive their respective Table Of Contents (TOCs). Examples of suggested journals included: *Science*, *Nature*, *Nature Genetics*, *PLos Computational Biology*, *PLos Genetics*, *BMC Genomics*, etc...
Receiving regularly TOCs of such high-quality scientific journals, should develop habits of reading scientific literature and enhance the participants awareness about progress and novelty in science.

I.2 Choosing "bibliographic projects"

The "bibliographic project" consisted of synthesizing the contents of about five selected papers relevant to a given topic. Projects aimed to foster participants to develop:
- good habits of critically reading scientific literature;
- ability to synthesize and summarize the content of scientific works;
- prepare and orally present this synthesis.

Examples of suggested topics included: Genome assembly methods[2], Genome alignment algorithms[3], Orthologs inference and clustering[4], Tree Of Life construction[5], Methods for genome structural variant analyses[6], Gene and Genome editing[7].

A formal talk and a written review were the final outcome of the project, that were due to be presented at the end of the course.

II. Prepare oral presentation and synthetic reviews

Participants had to train on how to prepare oral presentations, content and form, as well as on how to write synthetic reviews. The following three steps show how we proceeded.

II.1 Talks preparation and progress presentation

Students had to present visuals showing the progress in their respective bibliographic projects. They were assisted on how to:
- decide what to include and the logical plan to consider for the slide contents.

We suggested to include solely succinct and clear sentences per slide and to prepare a logical flow following reference[8]: few comments about the reasons for choosing the project topic (beginning); a plan for the talk, followed by the development of the

important and striking ideas (middle) and terminate with few slides indicating the take-home message (end).
- give a talk during Lab meetings.
Participants were prompted to outline clear and logical ideas. They had to state the content of their analyzed papers in a concise presentation and to follow the prepared slides, respecting the above-mentioned suggestions.
- face discussion and comments in an informal atmosphere.
Feedback from colleagues including positive comments as well as discrepancies and inconsistent parts of the talk, helped to improve the presentation content. This interaction also reinforced the cooperation and solidarity between the participants as well as their self-evaluation.

II.2 Reviews preparation and progress

Bibliographic reviews aimed to foster critical reading of papers, synthetic reports writing, fairly acknowledging references and consequently developing own analytical skills. From these reviews, we expected synthetic insights useful for all participants, promoting by the way scientific enrichment and knowledge dissemination.

Participants were suggested[9] to:
- take notes while reading by writing down essential sentences and ideas;
- list the major achieved results and used methods;
- point out any further outstanding question that needed further clarification;
- collect these notes to help writing the first draft of the review;
- rewrite, restructure and rethink the first drafts using own words will help improving the review;
- favor integrative final review focusing on common ideas, concepts and methods from the reviewed papers;
- carefully plan a logical structure for review writing as well as for the oral presentation, making sure all important ideas were logically reported without repetition;
- follow a plan consisting of a general introduction explaining the choice and the context of the topic, recapitulation of the main results, ideas and methods covered in the reviewed papers and a conclusion including take-home messages and perspectives.
- avoid plagiarism[10] by considering only own text and illustrations.

II.3 Papers selection from TOCs and presentation

The participants had to select at least one paper from the TOCs received during the week, that could be of interest for the audience and possibly discuss and comment on them.
The objectives were to train participants to:
- be aware of current developments in Bioinformatics and Genomics;
- Develop habits of regularly reading and seeking recent scientific literature;
- Summarize the content of such papers;
- Prepare and present a visual document reporting their synthesis.

Selected papers from TOCs were presented and discussed including if needed the cited references so that to clarify the progress that led to actual results and knowledge. It was interesting to note the diverse selected papers during each week and the consequent collective enrichment for all participants.
Examples of commented papers from TOCs included: genome editing, sequencing methods and tools review celebrating the 40 years of Sanger sequencing techniques, a new genome assembly method and tool, ancient genome analyses and news about retracted papers (detailed Lab meeting activities in: https://webext.pasteur.fr/tekaia/BCGAIPT2017/BCGAIPT2017_Prog.html, https://webext.pasteur.fr/tekaia/BCGAIPT2018/BCGAIPT2018_Prog.html).

TOCs follow up was helpful to keep the participants continuously immersed in the course atmosphere, to stay on top of the literature, to regularly discover contents of recently published works and to encourage selecting challenging papers to read carefully and commit to discuss and comment during the next Lab meeting.

III. Proceeding and leading Lab meetings

Projects preparation and presentation often triggered discussion that had to be initiated and coordinated by experienced leaders.

III.1 Develop scientific exchange and argumentation skills

Argumentation and discussion are key processes in learning and assessing new ideas and concepts. Participants were encouraged to commit themselves to commenting, questioning about topics and ideas introduced during projects and paper presentations as well as during lectures and practical sessions. We emphasized the importance of speaking, listening and involvement in argumentation as a mean for learning and developing analytical skills.

Although Lab meeting activities favored informal atmosphere, participants were asked to state claims and provide evidence in an organized way that allowed to express opinions and also to listen to others. All of this had a positive impact on improving projects presentations.

III.2 Lab meeting organization frequency

Regularly organizing Lab meetings was important for continuously keeping alive participants interest and attention. The set-up of one day per week for Lab meetings was mainly suggested by the regular progress checking of bibliographic projects and by the weekly availability of TOCs. A whole day was also needed to allow participants to show their project progress and to reasonably intervene without time constraint by suggesting ideas, explanations, questions and comments. Moreover, we had to stress the importance of these activities as a significant part in the course program.

III.3 Leading Lab meetings

Lab meetings were organized with no stringent rules about the timing, content and discussion but for better efficiency we opted to lead the activities by two senior

scientists respectively experienced in Biology and in Bioinformatics. Leadership was critical for multi-intervening participants with diverse backgrounds to run satisfactorily the meeting and keep it in the same time friendly, open and flexible.

A significant role of the leading scientists was to assist participants in efficiently reading and synthesizing publications, preparing and delivering oral presentations as well as to emphasize open discussion and ideas sharing and to make sure everyone takes effectively part in this organization by encouraging if needed some to ask questions, make comments and others to slow down their interventions.

Senior scientists had to thoroughly guide the participants in critically reading recent publications, particularly highlighting the corresponding gradual evolution of technologies and advances. They had to pay attention to the logical reasoning and to suggest if needed further reading of appropriate references including seminal articles or primers providing historical perspectives and context that made easy reading of recent papers. Also they had to guide participants in rigorously reporting paper contents by concentrating on the course topics: Bioinformatics and Genomics, avoiding by the way improvisation and diversion attempts.

Instructions on respecting ethical rules and scientific integrity, by excluding plagiarism and lack of rigor, benefitted from the timely published news features[10] about articles retraction.

Other contributions included the participant's preparation to communicate well-structured oral and written documents and to develop argumentation skills about concepts and topics reported in lectures presentations all along the course period.

IV. Final review presentation and Lab meetings evaluation

During the last week of the course, final reviews of the bibliographic projects and corresponding talks were formally presented. It was interesting to note the progress made by all participants in their presentations (form and content) as well as the acquired self-confidence they showed during the talks and the questions/comments sessions.

At the end of the course, participants evaluated the whole course program including Lab meeting activities[1]. The general trend was that participants positively appreciated these activities.

In Conclusion our experience showed the importance of including Lab meeting activities in a Bioinformatics and Genome Analyses course program and thus particularly to follow up and read scientific literature as part of the educational outcome of such a course. Rigorous discussion and exchange on scientific advances were significant components of such activities. They were essential means of training young researchers, instilling them novel scientific awareness about ethics and scientific integrity as well as self-confidence building.

Lab meetings significantly complemented the theoretical and practical parts of the course by introducing team working and communicating on scientific topics and constituted a collective enrichment by the collected presentations through the TOCs and bibliographic reviews. This studious atmosphere positively impacted the rest of the

course program, enhancing active participation and even making the teaching task easier.

Finally, we recommend fostering Lab meeting culture in similar courses, so that young researchers develop critical capacities to read, prepare, write, communicate and rigorously exchange on scientific information.

List of Abbreviations:

TOC: Table Of Content

Legend to Figure 1. Steps constituting the backbone of the followed procedure in the development and implementation of the Lab meeting activities.
The diagram shows the steps that are grouped into four main operational components:
I.) Training on reading scientific literature;
II.) Prepare oral presentation and synthetic reviews;
III.) Proceeding and leading Lab meetings and
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Key words characterizing respective activities and recommendations of each step are listed.

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Conflict of Interest

The authors declare no conflict of interest.

Key words: education, capacity building, scientific literature follow up, analytical skills, sharing ideas, communication, preparing and presenting reviews.

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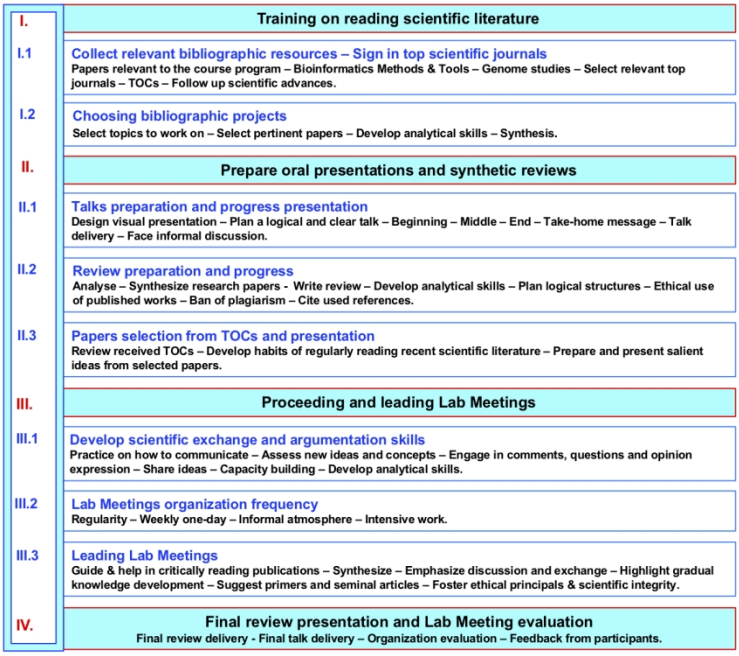

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